ACQUISITION,
TECHNOLOGY
AND LOGISTICS

OFFICE OF THE UNDER SECRETARY OF DEFENSE

3000 DEFENSE PENTAGON
WASHINGTON, DC 20301-3000

November 7, 2001

MEMORANDUM FOR U.S. MISSION TO NATO, ARMAMENTS COOPERATION DIVISION
BOX 200, PSC 81, APO AE 09724

SUBJECT: Draft STANAG 4416 (EDITION 1) – "NUCLEAR ELECTROMAGNETIC PULSE TESTING OF MUNITIONS CONTAINING ELECTRO-EXPLOSIVE DEVICES "

Reference document, AC/310-D/168, 9 November 1999, SAB.

The United States ratifies the agreement received under cover reference with reservations and editorial comments.

Ratification and implementation details are as follows:

	IMPLEMENTATION					
	Forecast Date			Actual Date		
RATIFICATION REFERENCE	NAVY	ARMY	AIR FORCE	NAVY	ARMY	AIR FORCE
Memo, OUSD(AT&L) DATED AS ABOVE	November 7, 2001			November 7, 2001		

NATIONAL IMPLEMENTING DOCUMENT: MIL-STD-464

RESERVATIONS: See attached DA Form 4797-R. (encl 1)

COMMENTS: See attached DA Form 4797-R. (encl 2)

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2 encl. as stated

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Reservations to STANAG 4416E1

NO (a)	NATION (b)	PAGE (c)	PARA (d)	LINE (e)	COMMENT(S) (f)	REASON(S) (g)
1	U.S.	B-3	1.1	3	**RESERVATION:** US reserves the right to use term electrically initiated device (EID) along with EED term	To be in agreement with national implementing document MIL-STD-464
2	U.S.	B-4	4.1	5	**RESERVATION:** Change " missile is enhanced" to " missile may be enhanced"	The amount & level depends on many factors, e.g. smokeless motors may not contribute to the NEMP coupling
3	U.S.	B-4	5.2	6	**RESERVATION:** Change " equipment" to " munitions or weapon system"	Change necessary to ensure term agrees with para 1.1
4	U.S.	B-5	6.c	1	**RESERVATION:** Change " controls" to " safety controls" . Change " equipment" to " instrumentation"	Change necessary to ensure term agrees with para 6.b and to emphasize the need for safety considerations in the controls

Enclosure 1

Comments to STANAG 4416E1

NO (a)	NATION (b)	PAGE (c)	PARA (d)	LINE (e)	COMMENT(S) (f)	REASON(S) (g)
1	U.S.	B-6	7.2.2	3	**COMMENT:** Change " should" to " will"	It is important that instrumentation not contribute to the munition's test response thus degrading the test results

Enclosure 2

STANAG 4416
(Edition 1)

NORTH ATLANTIC TREATY ORGANIZATION
(NATO)

NATO STANDARDIZATION AGENCY
(NSA)

STANDARDIZATION AGREEMENT
(STANAG)

SUBJECT: NUCLEAR ELECTROMAGNETIC PULSE TESTING OF MUNITIONS CONTAINING ELECTRO-EXPLOSIVE DEVICES

Promulgated on 26 August 2002

Jan H ERIKSEN
Rear Admiral, NONA
Director, NSA

RECORD OF AMENDMENTS

No.	Reference/date of amendment	Date entered	Signature

EXPLANATORY NOTES

AGREEMENT

1. This NATO Standardization Agreement (STANAG) is promulgated by the Director, NSA under the authority vested in him by the NATO Military Committee.

2. No departure may be made from the agreement without consultation with the tasking authority. Nations may propose changes at any time to the tasking authority where they will be processed in the same manner as the original agreement.

3. Ratifying nations have agreed that national orders, manuals and instructions implementing this STANAG will include a reference to the STANAG number for purposes of identification.

DEFINITIONS

4. Ratification is "In NATO Standardization, the fulfilment by which a member nation formally accepts, with or without reservation, the content of a Standardization Agreement" (AAP-6).

5. Implementation is "In NATO Standardization, the fulfilment by a member nation of its obligations as specified in a Standardization Agreement" (AAP-6).

6. Reservation is "In NATO Standardization, the stated qualification by a member nation that describes the part of a Standardization Agreement that it will not implement or will implement only with limitations" (AAP-6).

RATIFICATION, IMPLEMENTATION AND RESERVATIONS

7. Page iii gives the details of ratification and implementation of this agreement. If no details are shown it signifies that the nation has not yet notified the tasking authority of its intentions. Page iv (and subsequent) gives details of reservations and proprietary rights that have been stated.

FEEDBACK

8. Any comments concerning this publication should be directed to NATO/NSA - Bvd Leopold III, 1110 Brussels - BE.

STANAG 4416
(Edition 1)

NAVY/ARMY/AIR

NATO STANDARDIZATION AGREEMENT (STANAG)

NUCLEAR ELECTROMAGNETIC PULSE TESTING OF MUNITIONS CONTAINING ELECTRO-EXPLOSIVE DEVICES

Annexes:

A. Definitions.
B. Nuclear Electromagnetic Pulse Testing Procedures to determine The Safety and Suitability for Service of Munitions Containing Electro-Explosive Devices.

Related documents:

AECTP-100	Environmental Guidelines for Defence Materiel
AECTP-200	Environmental Testing - Definitions of Environments
AECTP-300	Climatic Environmental Tests
AECTP-400	Mechanical Environmental Tests
AECTP-500	Electrical Environmental Tests
AEP-4	Nuclear Survivability Criteria for Armed Forces Material and Installations
AEP-9 Vol. 5	NATO Manual of Simulators of Nuclear Weapons Effects - Simulators of Electromagnetic Pulse (EMP) Effects.
AEP-18	EMP Test Methods and Procedures
AOP-15	Guidance on the Assessment of the Safety and Suitability for Service of Non-Nuclear Munitions for NATO Armed Forces
STANAG 4238	Munition Design Principles, Electrical/Electromagnetic Environments

AIM

1. The aim of this agreement is to define the normal test procedures to be used in determining the safety and suitability for service of munitions containing electro-explosive devices (EEDs) and associated electrical/electronic sub-systems, in the Nuclear Electromagnetic Pulse (NEMP) environmental conditions specified in AEP-4 for NATO forces.

AGREEMENT

2. Participating nations agree:

   a. that the test procedures specified in annex B are adequate to determine the safety and suitability for service of munitions containing EEDs, and any associated electrical/ electronic sub-systems in any configuration of their life cycle in the NEMP environment specified in AEP-4;

   b. that this STANAG is the basis for continuing a working relationship on NEMP assessment and testing of munitions containing EEDs.

IMPLEMENTATION OF THE AGREEMENT

3. This STANAG is considered implemented by a nation when that nation has issued the necessary orders or instructions to its forces :

a. that all future munitions containing EEDs, intended for use or transport by NATO forces and which are required to be resistant to NEMP, will be assessed and/or tested in accordance with the agreement;

b. to provide other Nations with the assessment and/or test information detailed in the agreement to assist in the interoperability of NATO forces.

DEFINITIONS

The following definitions are used for the purpose of this agreement only:

1. PIN-TO-PIN MODE (PTP)

The normal manner in which a bridgewire EED will operate with the firing current flowing through the bridgewire attached to the two connections in the EED.

2. PIN-TO-CASE MODE (PTC)

This mode may be either:

a. the abnormal manner in which an EED will function where discharge occurs between one pin and the case of a two pin EED via the explosive filling.

b. the normal manner in which an EED will function where the firing current flows between the pin and the metal surrounding of a single-pin EED via the explosive filling.

3. ELECTRICALLY REPRESENTATIVE MATERIAL (ERM)

A material is called an "electrically representative material" (ERM) in the NEMP environment, if the real part (R) and imaginary part (X) of its radio frequency impedance (R+jX) in the frequency band 1 kHz-100 MHz are similar to those of the original material which has to be simulated.

4. INERT ELECTRO-EXPLOSIVE DEVICE

An EED with its explosive material has been removed. It may have the explosive material replaced by ERM but it retains the bridgewire, foil, etc., from which it is initiated.

5. INSTRUMENTED ELECTRO-EXPLOSIVE DEVICE

An inert EED which has sensors in contact or close proximity to the bridgewire or ERM to measure the thermal energy or power induced. This instrumentation is designed so that it shall not change the radio frequency (RF) impedance of the EED (both in pin-to-pin and pin-to-case modes).

6. BULK CURRENT INJECTION (BCI)

An injection technique used to drive currents through a cable by magnetic induction from a current transformer fed from a generator. The ratio between the voltage at the input of the current transformer and the current induced in the cable under test is called the" transfer impedance".

7. TEST SEQUENCE

A test sequence is a series of pulses (radiated or injected by BCI or applied by voltage probes) for a given configuration (electrical and geometrical) of the munition or the weapon system or the equipment.

NUCLEAR ELECTROMAGNETIC PULSE TESTING PROCEDURES TO DETERMINE THE SAFETY AND SUITABILITY FOR SERVICE OF MUNITIONS CONTAINING ELECTRO-EXPLOSIVE DEVICES.

LIST OF CONTENTS

1. INTRODUCTION

1.1 Both high altitude (exoatmospheric) and low altitude (endoatmospheric) Electromagnetic Pulse (EMP) are potential threats to munitions or weapon systems which contain electro-explosive devices (EEDs) and electrical/electronic components within the sub-systems associated with the operation of such devices. Degradation, damage or unintended functioning of such devices and components could result in an event which has either safety or operational consequences.

1.2 This document addresses NEMP tests which are used to determine whether the EEDs and/or electronic systems contained within a munition or associated system will remain safe and suitable for service after being exposed to the Nuclear Electromagnetic Pulse environments defined in AEP-4.

2. NEMP SIMULATORS

Simulators have been developed to generate a NEMP test environment. Each NEMP simulator has particular strengths and weaknesses depending on the test conditions and the weapon system to be tested. Some knowledge about the system to be tested and effects to be examined, is necessary for selecting an NEMP simulator. The simulator compromises are almost certainly greatest for endoatmospheric EMP. The appropriate simulator to be used for the test of munitions and weapon systems can be found with the support of guidance given in NATO publication AEP-9 vol 5. Testing alone will be unlikely to determine the safety and suitability for service of munitions.

3. ASSESSMENT

A safety and suitability for service assessment of the NEMP susceptibility of the munition and/or associated systems shall be conducted to determine whether testing is required. Limited guidance on conducting such an assessment is given in NATO Publication AEP-18. Where the analysis shows conclusively that the munition and its associated systems are not susceptible to the NEMP threat, the requirement for testing may be waived upon the approval of the appropriate national Safety authority.

4. ANALYSIS

Where the assessment demonstrates the potential for NEMP susceptibility, a coupling analysis shall be conducted for all relevant configurations and states of the weapon within its service life cycle. It shall determine the most significant orientations and layouts of the weapon both in the real case and within the simulated field. In addition the coupling analysis shall consider PTP and PTC firing modes including consideration of the electrical assembly or situation of the EED inside the weapon (EED with/without metallic case, grounded/not grounded metallic case).

4.1 CONFIGURATION ANALYSIS

In general, the most susceptible configuration to a NEMP occurs during preparations for a launch. At this time, external cables enter the munition creating antennas more capable of interacting with the pulsed electromagnetic field. Another susceptible configuration is the in flight missile where all electronic sub-systems are active and the electro-explosive devices are connected to the firing circuits. In addition, the possibility for maximising the NEMP coupling to the missile is enhanced due to the effective length of the missile being increased by the electrically conductive exhaust plume from its motor.

4.2 STRESS LEVELS ANALYSIS

The analysis shall attempt to relate the simulated stress levels on devices and components to those that could be experienced in an actual exposure. Levels of stress that can cause upset, damage or unintended events of a hazardous nature shall be indicated, particularly those applying to EED, given in terms of a no-fire threshold or switching level for electronic devices. Any relevant testing during the qualification of sub-systems, equipments and components would need to be considered. The analysis may include consideration of measurements to relate external fields and/or skin currents to cable currents; such measurements could be made at full threat or sub threat and use either pulse or CW signals.

5. GENERAL TEST REQUIREMENTS

5.1 TEST CONFIGURATION

5.1.1 Where testing is required, it should be performed in all the system configurations and field polarisations recognized as representative for the worst case situations likely to be encountered during the service life of the munition or weapon system.

5.1.2 An analysis of the life cycle of the munition or weapon system shall be undertaken to determine the possible exposure configurations of the test item; it may be necessary to test more than one configuration. Any protective caps or covers over connectors and/or shorting/grounding devices should be used during testing if they would be in place during the part of the logistics cycle simulated by the particular test.

5.2 CONDITION OF TEST ITEM

The item selected for testing shall be fully assembled either with live **EEDs** or instrumented EEDs. Where there are associated electrical/electronic sub-systems fitted, these shall be fully functional. All other explosive material is to be removed. If it is considered that the presence of this material would affect the degree of coupling to the components being assessed, then it should be replaced by ERM. The degree of similarity between the actual material and the ERM shall be agreed between the assessor and the equipment sponsor/project management. The test item can be exposed to simulated fields both in a powered and unpowered condition. Where power supplies are not integral with the system, precautions shall be taken to protect them against the NEMP effects.

6. TEST PLAN

A test plan shall be prepared for each munition or weapon system and/or associated systems on which tests are conducted. This test plan shall include, but not be limited to, the following:

a. a description of the munition or weapon system and associated systems and the test configuration of the munition and surrounding systems, e.g., package mode, armed/unarmed, loaded/unloaded, and its position with regard to the Electric (E) and Magnetic (H) fields associated with the NEMP;

b. a description of the test facilities to be employed to include instrumentation and simulator characteristics, environment measurement techniques, and calibration procedures;

c. the safety controls to be taken to protect personnel and equipment in the event the EEDs function during the test.

6.1 The test plan shall require the following pre-test data and information:

a. the sequence of system configurations and functional modes to be investigated;

b. the test levels and waveforms to be generated by the simulator associated with each of the above configurations/modes of operation;

c. the need for instrumenting sensitive devices and components and the selection and type of instrumentation to be used, particularly if energy sensitive devices, which may respond to single pulse inputs, are used in the munition;

d. the need for other monitoring equipment, e.g., current probes, and their position in each layout;

e. the number of times each munition and its associated sub-systems are to be tested in each configuration/mode and whether items like EED's are to be replaced between successive electromagnetic pulses.

6.2 The test plan shall require the following data/information to be recorded during or following the test:

a. the measured levels, waveforms and frequency spectra of the simulated NEMP for each test;

b. the measured response of EEDs or sensitive components;

c. any other pertinent information such as current induced, ambient conditions etc.;

d. any testing of sensitive components in electronic circuits made after exposure to the simulated NEMP to determine cause of parameter change or damage mechanism.

7. TEST EQUIPMENT

7.1 SIMULATORS

The dimensions of the system to be tested largely governs the choice of simulator. Some can accommodate a large aeroplane and others are only large enough to accommodate minor equipment.

7.1.1 Field intensity uniformity

It is necessary to ensure that the field does not vary significantly (more than 6 dB) in level over the volume of space which the particular configurations of the system will occupy.

7.1.2 Simulator loading

All material placed in the radiated field "loads" the environment. In some simulators it is necessary to ensure that the field reforms after transiting, say a large container or tank, before the line termination is reached. It is necessary in a bounded wave simulator to ensure that the system will not short out the field to such an extent that breakdown occurs between the upper surface of the line and the equipment.

7.2 MEASURING SYSTEMS

7.2.1 If the munition or the weapon system has to be instrumented to measure induced currents and/or voltages at critical circuit locations (as determined by analysis as described in paragraph 4), the following measuring systems have to be used:

a. a measuring system for electronics associated with EEDs selected from AEP-18, Chapter 8 or AECTP-500 (STANAG 4370);

b. a measuring system for EEDs that monitors PTP and where necessary PTC induced current or energy. The data transmission system used between instrumented devices and their recording equipment shall not distort the applied field unacceptable, induce spurious signals in the EEDs or alter the data. This is commonly accomplished by using fibre optics or microwaves to transmit data between the EED under test and the remotely positioned recording instrumentation.

7.2.2 Alternatively, data can be brought out via well shielded coaxial lines through connectors in the weapon skin. The lines should be routed perpendicular to the **E** field and surrounded by RF absorber material to minimize electromagnetic coupling. Tests will be then performed to ensure there are no instrumentation induced errors.

7.3 USE OF LIVE EEDS

When live EEDS are to be used (see specific procedures at § 8.3.1), measurement of their resistance before and after test can be made using a safety ohmmeter. The measurement can provide an early indication that significant change has occurred but other tests of a non destructive nature should be employed to examine their condition after test, particularly if **EED** duding is suspected.

8. PROCEDURE

8.1 GENERAL

8.1.1 This section provides a general outline of the procedures to be used in the NEMP testing of munitions and weapon systems. A detailed procedure shall be developed for use by personnel conducting the testing (see figure 1).

8.1.2 The munition or weapon system, in its most vulnerable configurations, shall be exposed to the simulated NEMP. For all test configurations, the munition shall be oriented with reference to the incident E and H field to ensure maximum coupling of energy to all components of concern. If maximum coupling to different components requires different orientations, or if worst case coupling cannot be determined a priori, various orientations shall be used to ensure testing in the worst case conditions.

8.2 TEST ARRANGEMENTS

The arrangements which give maximum coupling will be used if known; otherwise the following arrangements will be used:

a. Monopole: The munition under test shall be supported by a dielectric structure. The major axis of this arrangement shall be oriented parallel to the incident E field generated by the simulator. The extremity of the munition closest to the ground is connected to ground. The arrangement then resembles a monopole antenna in maximum coupling mode. The grounding method used shall not increase the coupling to the munition;

b. Dipole: The munition under test shall be supported by dielectric structure. No ground connection is used. The arrangement resembles a dipole antenna capacitively coupled to ground.

Note: The placement of the munition or weapon system in either monopole or dipole configuration may not constitute a worst case condition. Some weapons receive more energy when attached to launch platforms, under wing pylons, missile rails, etc. than if left out in free space. Further, the drive currents from attached umbilicals must be considered when determining the safety of ordnance in an NEMP field. If survivability in these configurations is required, realistic tests should be designed which include ordnance handling gear, platform characteristics and position of exposure.

8.3 SPECIFIC TEST PROCEDURES

8.3.1 TEST PROCEDURES WITH LIVE EEDS

The tests with live EEDs mounted inside the munition or weapon system are essentially conducted to assess the pin-to-case mode effects (when the analysis made in §4 has demonstrated this firing mode was likely to occur or the explosive material between the pins and the case has an effect on the line impedance of the EED circuitry).

The response to a single pulse or progression of pulses interacting with an EED in a firing circuit could be a change in the EED electrical sensitivity, eg a bridgewire EED can be desensitised with the effect that more current is needed for initiation. Since the effects are generally produced inside the active material filled between the pins and the case, live **EED**s have to be used.

Two test procedures A and B, are possible:

8.3.1.1 TEST PROCEDURE A

This test procedure which is only possible when a current probe can be physically mounted on the circuitry near to the EED inside the munition or the weapon system, consists of two tests A1 and A2 and of an analysis of the reactions which may occur during the test A2.

TEST A1 ON THE MUNITION OR THE WEAPON SYSTEM

The test A1 consists of measuring the common mode current in the live EED by Bulk Current Measurement (BCM) when the munition or the weapon system is irradiated with the simulated NEMP to allow the transfer function between the pulse NEMP waveform and the common mode current measured on the EED circuitry to be obtained. This test leads by extrapolation to the shape and the value of the common mode current (Icm1) which should occur in the EED when the munition is in the real NEMP environment.

The advantage of this test is that the original value of the complex impedance of the explosive material between the pins and the case of the EED or the ground reference of the munition is maintained.

TEST A2 ON THE SUB-SYSTEMS

The test A2, which generally follows the test A1, is a Bulk Current Injection (BCI) test which consists of injecting current pulses directly in the sub-system containing the EED (sub-system removed from the weapon) to directly fire the EED. The safety margin between the common mode current (Icm2) leading to a reaction of the EED and the common mode current (Icm1) measured by (BCM) when the sub-system was inside the weapon in the NEMP simulated environment can then be evaluated.

Three types of reaction may occur:

a. modification of the RF impedance of the EED in PTC mode;

b. modification of the direct current (DC) resistance of the EED in PTP mode;

c. firing of the EED;

d. no effect on the EED.

It has to be noted that the test currents injected (BCI) should have the same shape as those measured on the munition or weapon system (by BCM) but should have higher levels. The BCI and BCM tests have to be conducted using the methodology described in AECTP-500 (STANAG 4370). The BCI test has to be conducted directly on the individual sub-systems in a laboratory equipped with special protection against the effects of explosion of live EEDs.

NUMBER OF EEDS NEEDED IN THE TEST A2

Several EEDS are needed in order to take account of the variability of their electrical characteristics. For the tests where the reaction is of type a) or b) as described above, the radio frequency PTC impedance and the direct current PTP resistance of the EEDs have to be measured and recorded for each EED prior to and after current injection (provided no-fire has occurred).

For each sub-system the minimal number of EEDs to be tested is 5 for each test sequence.

For the tests where a reaction of type a), or b) occurs for one or more of the five EEDs the BCI test has to be reconducted on five new live EEDs with a lower BCI level to find the level where no reaction occurs.

For the tests where the reaction is of type c), the no fire threshold energy (NFT) of the family of the EED has to be evaluated with a statistical method (Bruceton, Probit, One Shot method) and a minimum of 50 EEDs is required for this test.

For the test where no reaction occurs (reaction of type d) the test is considered as completed when the safety margin between Icm2 and Icm1 is higher that or equal to the required safety margin. When no safety margin has been defined a fallback safety margin value of 20 dB can be used.

The test procedure A is often preferred to that following because it is easier to change a live EED in a sub-system rather than in a weapon. The procedure also has an advantage in that margins are determined between the measured currents on the firing lines of the whole munition or weapon system during the NEMP simulated illumination and the no fire threshold level or reaction/dudding level of the EEDs.

8.3.1.2 TEST PROCEDURE B

This test procedure consists of testing the munition or the weapon system containing live EEDs (but with all other explosive material removed) but involves no instrumentation during test. This procedure is used when it is not possible to place measuring systems inside the munition or the weapon system and when it is required to assess one or both pin-to-pin and pin-to-case mode effects.

The test procedure used consists of recording DC resistances and RF impedances of each EED prior to and after the full threat level NEMP illumination of the munition or the weapon system (if the EEDs do not fire).

The number of EED samples used is critical in the assigning of relevance to NEMP test results. Because this procedure is go/no-go in nature, the results can only be examined statistically. Little confidence should be given to the fact that one tested munition survived a test threat. Since it is long and difficult to take to pieces the sub-systems of a munition and to change the EEDs, a minimum of 8 EEDs is required for this test to demonstrate a reliability level of 75% with a confidence level of 90%.

8.3.2 TEST PROCEDURE WITH INSTRUMENTED EEDS (PROCEDURE C)

This test procedure called PROCEDURE C is conducted to assess the pin-to-pin mode effects with instrumented EEDs mounted inside the munition or weapon system.

This test procedure consists of measuring the transient temperature reached by the bridgewire of an inert EED which is installed in the weapon in place of a live EED during the NEMP simulated pulse. The measurement has to be made with a temperature sensor (optical sensor or electrical thermocouple) which is placed close to the bridgewire of the EED but without any electrical contact with it. Both thermal sensor and the EED have to be calibrated together with a pulse NEMP generator in order to determine the calibration function between the energy received by the bridgewire and its peak temperature.

The measurement has to be conducted with special sensors which have a low thermal time constant (same order as the thermal time constant of the EED) and a fast response.
The energy measured in the instrumented EEDs can then be compared with the no fire threshold energy of the EED in order to give a safety margin or a probability of firing the EED for the NEMP pulse level of the test.

8.3.3 TEST PROCEDURE WITH VOLTAGE PROBES (PROCEDURE D)

This test procedure, called PROCEDURE D, can be used as an alternative to test PROCEDURE A (with live EEDs) to assess the pin-to-case mode effects when it has been demonstrated that the effect of the explosive material on the line impedance of the circuitry of the EED can be neglected.

This test procedure requires a voltage probe (voltage divider) to be physically mounted inside the munition or the weapon system, in place of the EED (which has been removed).It consists of two tests, D1 and D2, and of an analysis of the reactions which may occur during test D2.

TEST D1 ON THE MUNITION OR THE WEAPON SYSTEM

The test D1 consists of measuring the common mode voltage (Vcm) between each pin of the EED and its ground reference when the EED has been removed and replaced by a probe (which acts as a voltage divider) when the munition or the weapon system is irradiated with the simulated NEMP. This procedure allows the transfer function between the pulse NEMP waveform and Vcm, measured on the EED circuitry, to be obtained.

The result of this test leads, by extrapolation, to the shape and the value of the common mode voltage (Vcm1) which would occur between the EED pins and that ground reference in the full NEMP environment.

Note 1: This procedure is different from the test procedure A described above since it does not keep the original value of the complex impedance of the explosive material between the pins and the case of the EED or the ground reference of the munition.

Note 2: The voltage data given by the probe are transmitted to the recording instrumentation by using fibre optics.

TEST D2 ON THE SUB-SYSTEMS

The test D2 which follows the test D1 consists of applying voltage pulses directly to the sub-system containing the EED (sub-system removed from the weapon) to directly fire the EED. The safety margin between the common mode voltage (Vcm2), leading to a reaction of the EED, and the common mode voltage (Vcm1) obtained with test D1 is then evaluated.

Three types of reaction may occur:

a. modification of the RF impedance of the EED in PTC mode;

b. modification of the direct current (DC) resistance of the EED in PTP mode;

c. firing of the EED;

d. no effect on the EED.

It has to be noted that the test voltage pulses should have the same shape as those measured on the munition or weapon system by test D1 but should have higher levels. The D1 and D2 tests have to be conducted using the methodology described in AECTP-500 (STANAG 4370). The test D2 has to be conducted directly on the individual sub-systems or EEDs in a laboratory equipped with special protection against the effects of explosion of live EEDs.

NUMBER OF EEDS NEEDED IN THE TEST D2

Several EEDS are needed in order to take account of the variability of their electrical characteristics. For the tests where the reaction is of type a) or b) as described above, the radio frequency PTC impedance and the direct current PTP resistance of the EEDs have to be measured and recorded for each EED prior to and after voltage injection (provided no-fire has occurred).

For each sub-system the minimum number of EEDs to be tested is 5 for each test sequence.

For the tests where a reaction of type a), or b) occurs for one or more of the five EEDs the test D2 has to be reconducted on five new live EEDs with a lower voltage level to find the level where no reaction occurs.

For the tests where the reaction is of type c), the no fire threshold energy (NFT) of the family of the EED has to be evaluated with a statistical method (Bruceton, Probit, One Shot method) and a minimum of 50 EEDs is required for this test.

For the test where no reaction occurs (reaction of type d) the test is considered as completed when the safety margin between the common mode voltage (Vcm2) injected in the sub-system containing the EED and the common mode voltage (Vcm1) is higher than or equal to the required safety margin. When no safety margin value has been defined a fallback value of 20 dB can be used.

8.3.4 TEST PROCEDURE E FOR ASSOCIATED ELECTRICAL/ELECTRONIC SYSTEMS

The test procedure to be conducted on the electrical/electronic systems which are associated with the EEDs is called PROCEDURE E. This procedure consists of conducting functional tests of these electrical/electronic sub-systems prior to and after each testing sequence (if possible) or at the end of all the tests. The test procedure can be conducted with live or instrumented EEDs.

9. NUMBER OF TESTS

9.1 The number of tests to be conducted on a munition or a weapon system depends on the number Nc of its different electrical and geometrical configurations and on the effects being addressed, namely

a. effects on EEDs (in PTP and PTC mode);

b. effects on electronic associated systems.

The number of tests also differs according to whether the munition contains live EEDs probes or instrumented EEDs.

9.2 The guide to the number of EEDs and test pulses required is given in the table 1 below which gives for each procedure:

a. the number Ne of EEDs;

b. the minimum number of pulses Np for each test sequence at a given threat level;

c. the minimum number of threat levels Nl which have to be applied to take account of non-linearity phenomena.

Therefore, the number of pulses to apply for a NEMP test is depending on Ne, Np, Nl and Nc.

TABLE 1:

Type of procedure	Number of EEDs (Ne)	Minimum number of pulses for each test sequence (Np)	Minimum Number of threat levels (Nl)	Notes
A1	1	5	3	-
A2	5	10	2	(1)
B	8	15	2	-
C	1	3	2	(2)
D1	-	5	3	(3)
D2	5	10	2	(1)
E	1	-	-	(4)

(1) the number of EEDs depends on the result of the test. For reactions of type a) and b) 5 or a multiple of 5 EEDs are required. If resistance measurement shows significant change after a single pulse then testing shall be conducted again with 5 additional EEDs but with a lower level of injection in order to find the level where no reaction of the EED occurs.

The number of EEDs for reactions of type c) is greater than 50.

(2) test with instrumented EED;

(3) test with voltage probes (the EED has been removed);

(4) the test is conducted after each test sequence or at the end of the tests. The EEDs can be live or instrumented.

10. ACCEPTANCE CRITERIA

If acceptance criteria have been developed for NATO use for particular classes of a munition or weapon system and are given elsewhere in other STANAGs, these shall have precedence. If none exist, the following criteria shall be used:

10.1 FAILURE CRITERIA

10.1.1 Where either a passive (unpowered) or partially/fully active (powered up) munition or weapon is required only to be safe but not usable after NEMP exposure, the following conditions shall be met:

a. for a munition in which EEDs are held in an unarmed state, i.e., out of line, evidence of the EEDs having fired or duded does not constitute failure;

b. for a munition in which EEDs are in a permanently armed state and hence, if fired in a live munition, would cause it to function in an unacceptable way, the evidence of the EEDs having fired, duded or damaged sufficiently to cause significant physical change shall constitute failure (reaction described in § 8.3.1.1).

10.1.2 For either a passive or partially active munition or weapon system required to be safe and capable of operational use after exposure, evidence of resistance change, degradation or other physical damage to an EED or its associated electronic sub-system may constitute failure unless further examination or testing can show that the degradation is acceptable and will not impair either the safety or the subsequent performance of the munition.

10.1.3 For a munition or weapon system which is fully active (powered up) during NEMP exposure and required to be safe and capable of completing its operational mission, degradation shall not unacceptably impair either its safety or performance during use. Where the degradation could result in a hazard or significant loss of performance, it will constitute a failure. A temporary loss of performance for some systems may be acceptable.

10.2 SAFETY MARGINS

10.2.1 It should be demonstrated that there is a safety margin between the levels of stress that can cause upset, damage or unintended events of hazardous nature(particularly those applying to EED given in terms of a no fire threshold or switching levels for electronic devices) and the levels of stress likely to be encountered in the NEMP environment specified in AEP-4.

10.2.2 Safety margins are to be agreed by the National Authority, and are applicable to instrumented systems since they must be related to the no fire thresholds of EEDs or upset levels of electronic devices.

11. REPORTING REQUIREMENTS

11.1 Test Report:

A test report shall be provided that includes, but is not limited to, the following:

a. the test plan;

b. the analysis upon which the plan was founded;

c. the tests and results;

d. any deviations from the test plan including, if made, a rationale on the reasons for the changes;

e. the analysis of the test results and their implications for the safety and suitability for service of the system in the NEMP environment specified in AEP-4;

f. a statement as to whether or not the munition and its associated systems have met the criteria specified. The rationale leading to the conclusion should include all assumptions and engineering judgements made.

11.2 Assessment Report:

When the safety and suitability for service assessment of the susceptibility of the munition/ weapon system shows conclusively that the system is either not susceptible or not unacceptably susceptible to the NEMP threat specified in AEP-4 or will not be likely encounter the threat, NEMP testing may be waived by the National authority. The results of the Assessment report shall be provided in lieu of a test report.

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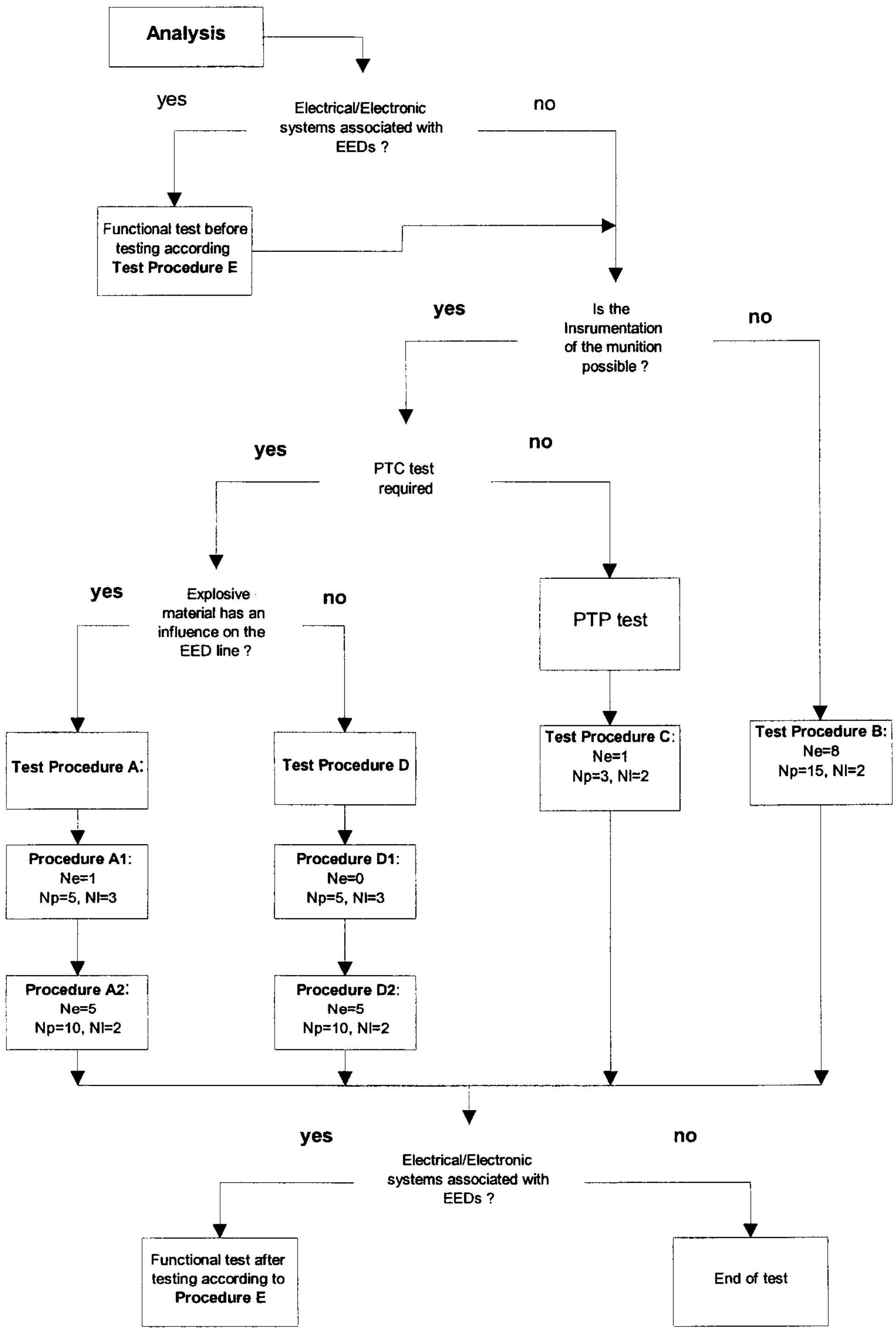

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Figure 1

RATIFICATION AND IMPLEMENTATION DETAILS
STADE DE RATIFICATION ET DE MISE EN APPLICATION

NATION	NATIONAL RATIFICATION REFERENCE DE LA RATIFICATION NATIONALE	NATIONAL IMPLEMENTING DOCUMENT NATIONAL DE MISE EN APPLICATION	IMPLEMENTATION / MISE EN APPLICATION					
			INTENDED DATE OF IMPLEMENTATION/ DATE PREVUE POUR MISE EN APPLICATION			DATE IMPLEMENTATION WAS ACHIEVED/ DATE REELLE DE MISE EN APPLICATION		
			NAVY MER	ARMY TERRE	AIR	NAVY MER	ARMY TERRE	AIR
BE	GSP 01/101644 of/du 30.10.01	Not implementing/ Ne met pas en application						
CA	2441-4416 (DAPM 4-4) of/du 18.10.00	STANAG	12.00	12.00	12.00			
CZ +	6/2-21/2000-1419 of/du 04.10.00	Not implementing / Ne met pas en application						
DA +	FKO MAM3 204.69-S4416 9912145-003 of/du 05.07.00	STANAG	11.02	11.02	11.02			
FR								
GE	BMVg- Fü S IV 1 Az 03-51-60 of/du 19.04.01	STANAG	12.02	12.02	12.02			
GR								
HU								
IT								
LU	BO 6693/99 of/du 14.01.00	Not implementing / Ne met pas en application						
NL *	M2001000776 of/du 14.02.01	STANAG				08.02	08.02	08.02
NO	MAS 104/00/FO/LST/BEE/ of/du 10.08.00	STANAG	11.02	11.02	11.02			
PL	19/ROK/P of/du 10.06.00	Not implementing/Ne met pas en application						
PO								
SP	323/05/NI N° 14270 of/du 20.06.02	Not implementing/Ne met pas en application						
TU								
UK	D/DStan/12/15/4416 of/du 26.01.00	STANAG	08.02	08.02	08.02			
US *	OUSD(A&T) memo of/du 07.11.01	MIL-STD-464	11.02	11.02	11.02			

* See reservations overleaf/voir réserves au verso
+See comments overleaf/Voir commentaires au verso
X Service(s) implementing/Armées mettant en application

RESERVATIONS/RESERVES

THE NETHERLANDS	NEMP testing will only take place if on the basis of a hazard analysis (accordiate AOP-15) NEMP is regarded as a threat.
PAYS-BAS	*Les essais relatifs à l'impulsion électromagnétique d'origine nucléaire ne seront réalisés que sur la base d'une analyse du risque (conformément à l'AOP-15), cette impulsion étant considérée comme une menace.*
UNITED STATES	US reserves the right to use term electrically initiated device (EID) along with EED term.
ETATS-UNIS	*Les Etats-Unis se réservent le droit d'utiliser le terme de dispositif à déclenchement électrique (EID) conjointement à celui de dispositif électropyrotechnique (EED).*

COMMENTS/COMMENTAIRES

CZECH REPUBLIC	An implementation should require high charges for providing of own realization by the tests in accordance with this STANAG. There are note ensured financial resources for testing equipment acquisition and making of tests.
REPUBLIQUE TCHEQUE	*La mise en application de ce STANAG nécessiterait des frais élevés pour réaliser les essais selon les critères exigés. Les moyens financiers requis pour acquérir le matériel nécessaire et réaliser les essais ne sont pas garantis.*
DENMARK	Paragraph 3.a. The Danish Army considers this paragraph to apply to the development of electro-explosive devices (EED), or munitions containing EED. As such, the responsibility for testing rests with the developing nation.
DANEMARK	*Paragraphe 3.a. Les forces terrestres du Danemark estiment que ce paragraphe s'applique au développement de dispositifs électropyrotechniques, ou de munitions contenant de tels dispositifs. A ce titre, c'est le pays chargé du développement qui est responsable des essais.*